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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

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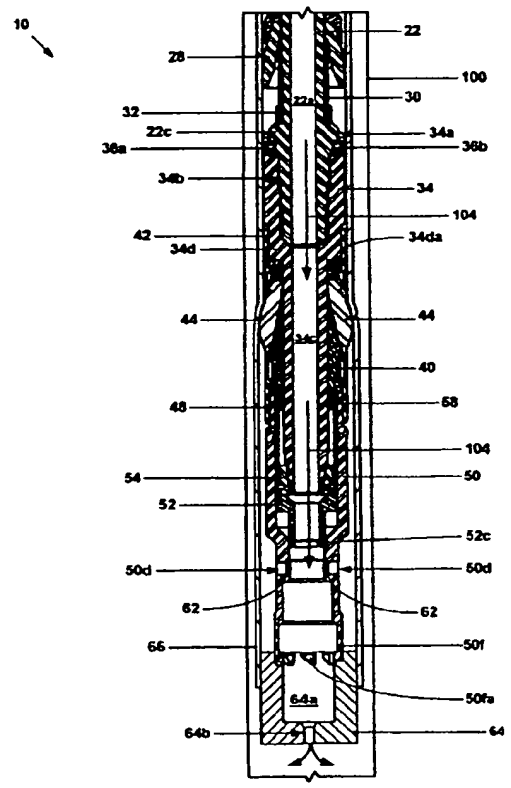
(54) Title: COLLAPSIBLE EXPANSION CONE



(57) Abstract: An apparatus for radially expanding and plastically deforming an expandable tubular member (66) includes a collapsible expansion cone (44).

ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
East: (collaps$3 expan$5) with cone$1)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,842,082 A (SPRINGER) 27 June 1989 (27.06.1989), see entire document, especially Figs. 27-30.	20, 23
A	US 6,491,108 B1 (SLUP et al.) 10 December 2002 (10.12.2002), see entire document.	20-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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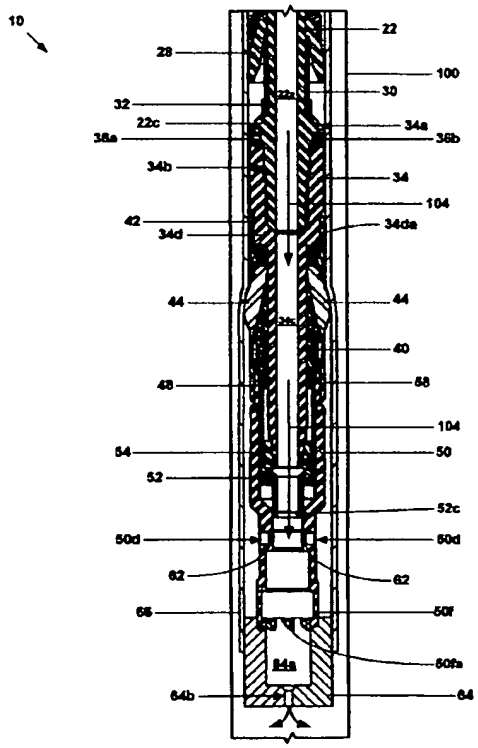

(57) Abstract: An apparatus for radially expanding and plastically deforming an expandable tubular member (66) includes a collapsible expansion cone (44).

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AMENDED CLAIMS

[Received by the International Bureau on 27 June 2004 (27.07.2004); original claims 1-21 and 23-32 unchanged, original claim 22 replaced by amended claim 22, claims 33-70 added

a lower cam assembly coupled to the lower tubular support member comprising:

a tubular base coupled to the lower tubular support member; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper expansion cone segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower expansion cone segments interleaved with cam arms of the lower cam assembly, each lower expansion cone segment pivotally coupled to the internal flange of the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly; and wherein the apparatus further comprises:

means for releasably coupling the upper tubular support member to the lower tubular support member; and

means for limiting movement of the upper tubular support member relative to the lower tubular support member.

22. The apparatus of claim 21, further comprising:

means for pivoting the upper expansion cone segments; and

means for pivoting the lower expansion cone segments.

23. The apparatus of claim 20, further comprising:

means for pulling the collapsible expansion cone through the expandable tubular member.

24. A collapsible expansion cone, comprising:

an upper cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper expansion cone segments interleaved with the cam arms of the upper cam assembly;

a lower cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the

member using the cup seals.

31. (Original) The method of claim 28, wherein the tubular support member comprises an upper tubular support member and a lower tubular support member; and wherein collapsing the collapsible expansion cone comprises displacing the upper tubular member relative to the lower tubular support member.

32. (Original) The method of claim 31, wherein the collapsible expansion cone comprises:
an upper cam assembly comprising:
a tubular base; and
a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;
a plurality of upper expansion cone segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the upper tubular support member;
a lower cam assembly comprising:
a tubular base; and
a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper expansion cone segments;
wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and
a plurality of lower expansion cone segments interleaved with cam arms of the lower cam assembly, each lower expansion cone segment pivotally coupled to the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly.

33. (New) A method of radially expanding and plastically deforming an expandable tubular member, comprising:
supporting the expandable tubular member using a tubular support member and a collapsible expansion device;
injecting a fluidic material into the tubular support member;
sensing the operating pressure of the injected fluidic material within a first interior portion of the tubular support member;

displacing the collapsible expansion device relative to the expandable tubular member when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the first interior portion of the tubular support member;

sensing the operating pressure of the injected fluidic material within a second interior portion of the tubular support member; and

collapsing the collapsible expansion device when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the second interior portion of the tubular support member.

34. (New) The method of claim 33, further comprising:

pulling the collapsible expansion device through the expandable tubular member when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the first interior portion of the tubular support member.

35. (New) The method of claim 34, wherein pulling the collapsible expansion device through the expandable tubular member comprises:

coupling one or more cup seals to the tubular support member above the collapsible expansion device;

pressuring the interior of the expandable tubular member below the cup seals; and

pulling the collapsible expansion device through the expandable tubular member using the cup seals.

36. (New) The method of claim 33, wherein the tubular support member comprises an upper tubular support member and a lower tubular support member; and wherein collapsing the collapsible expansion device comprises displacing the upper tubular member relative to the lower tubular support member.

37. (New) A system for radially expanding and plastically deforming an expandable tubular member, comprising:

means for supporting the expandable tubular member using a tubular support member and a collapsible expansion device;

means for injecting a fluidic material into the tubular support member;

means for sensing the operating pressure of the injected fluidic material within a first interior portion of the tubular support member;

means for displacing the collapsible expansion device relative to the expandable tubular member when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the first interior portion of the tubular support member;

means for sensing the operating pressure of the injected fluidic material within a second interior portion of the tubular support member; and

means for collapsing the collapsible expansion device when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the second interior portion of the tubular support member.

38. (New) The system of claim 37, further comprising:

means for pulling the collapsible expansion device through the expandable tubular member when the sensed operating pressure of the injected fluidic material exceeds a predetermined level within the first interior portion of the tubular support member.

39. (New) The system of claim 38, wherein means for pulling the collapsible expansion device through the expandable tubular member comprises:

means for coupling one or more cup seals to the tubular support member above the collapsible expansion device;

means for pressuring the interior of the expandable tubular member below the cup seals; and

means for pulling the collapsible expansion device through the expandable tubular member using the cup seals.

40. (New) The system of claim 37, wherein the tubular support member comprises an upper tubular support member and a lower tubular support member; and wherein means for collapsing the collapsible expansion device comprises means for displacing the upper tubular member relative to the lower tubular support member.

41. (New) A method of radially expanding and plastically deforming a tubular member, comprising:

pressurizing an interior portion of the tubular member; and

displacing an expansion device through the pressurized interior portion of the tubular member.

42. (New) The method of claim 41, wherein pressurizing an interior portion of the tubular member comprises pressurizing an annular interior portion of the tubular member.

43. (New) The method of claim 41, wherein displacing an expansion device through the pressurized interior portion of the tubular member comprises pulling the expansion device through the pressurized interior portion of the tubular member.

44. (New) The method of claim 43, wherein pulling the expansion device through the pressurized interior portion of the tubular member comprises using the operating pressure of the pressurized interior portion of the tubular member to pull the expansion device through the pressurized interior portion of the tubular member.

45. (New) A system for radially expanding and plastically deforming a tubular member, comprising:

means for pressurizing an interior portion of the tubular member; and

means for displacing an expansion device through the pressurized interior portion of the tubular member.

46. (New) The system of claim 45, wherein means for pressurizing an interior portion of the tubular member comprises means for pressurizing an annular interior portion of the tubular member.

47. (New) The system of claim 45, wherein means for displacing an expansion device through the pressurized interior portion of the tubular member comprises means for pulling the expansion device through the pressurized interior portion of the tubular member.

48. (New) The system of claim 47, wherein means for pulling the expansion device through the pressurized interior portion of the tubular member comprises means for using the operating pressure of the pressurized interior portion of the tubular member to pull the expansion device through the pressurized interior portion of the tubular member.

49. (New) An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:

an upper tubular support member;

one or more cup seals coupled to the exterior surface of the upper tubular support member for sealing an interface between the upper tubular support member and the expandable tubular member;

an upper cam assembly coupled to the upper tubular support member comprising:

a tubular base coupled to the upper tubular support member; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining a camming surface;

a plurality of upper expansion segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the tubular support member;

a lower tubular support member; and

a lower cam assembly coupled to the lower tubular support member comprising:

a tubular base coupled to the lower tubular support member; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining a camming surface that mates with a corresponding one of the upper expansion segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower expansion cone interleaved with cam arms of the lower cam assembly, each lower expansion cone pivotally coupled to the lower tubular support member and mating with the camming surface of a corresponding one of the cam arms of the upper cam assembly;

wherein the lower expansion segments interleave and overlap the upper expansion segments; and

wherein the upper and lower expansion segments together define an external surface for plastically deforming and radially expanding the expandable tubular member.

50. (New) The apparatus of claim 49, wherein the upper tubular support member comprises:

a safety collar;

a torque plate coupled to the safety collar comprising a plurality of circumferentially spaced apart meshing teeth at an end;

an upper mandrel comprising a plurality of circumferentially spaced apart meshing teeth at one end for engaging the meshing teeth of the torque plate and an external flange at another end; and

a lower mandrel coupled to the external flange of the upper mandrel comprising an external flange comprising a plurality of circumferentially spaced apart meshing teeth.

51. (New) The apparatus of claim 50, wherein the tubular base of the upper cam assembly comprises a plurality of circumferentially spaced apart meshing teeth for engaging the meshing teeth of the external flange of the lower mandrel.

52. (New) The apparatus of claim 50, further comprising:

a stop nut coupled to an end of the lower mandrel for limiting the movement of the lower tubular member relative to the lower mandrel.

53. (New) The apparatus of claim 50, further comprising:

locking dogs coupled to the lower mandrel.

54. (New) The apparatus of claim 49, wherein the lower tubular support member comprises:

a float shoe adapter comprising a plurality of circumferentially spaced apart meshing teeth at one end, an internal flange, and a torsional coupling at another end;

a lower retaining sleeve coupled to an end of the float shoe adapter comprising an internal flange for pivotally engaging the lower expansion segments; and

a retaining sleeve received within the float shoe adapter releasably coupled to the upper tubular support member.

55. (New) The apparatus of claim 54, wherein an end of the retaining sleeve abuts an end of the tubular base of the lower cam assembly.

56. (New) The apparatus of claim 54, wherein the tubular base of the lower cam assembly comprises a plurality of circumferentially spaced apart meshing teeth for engaging

the meshing teeth of the float shoe adaptor.

57. (New) The apparatus of claim 64, further comprising:

a float shoe releasably coupled to the torsional coupling of the float shoe adaptor; and

an expandable tubular member coupled to the float shoe and supported by and movably coupled to the upper and lower expansion segments.

58. (New) The apparatus of claim 49, further comprising:

one or more shear pins coupled between the upper tubular support member and the lower tubular support member.

59. (New) The apparatus of claim 49, further comprising:

a stop member coupled to the upper tubular support member for limiting movement of the upper tubular support member relative to the lower tubular support member.

60. (New) The apparatus of claim 49, further comprising:

a float shoe releasably coupled to the lower tubular support member that defines a valveable passage; and

an expandable tubular member coupled to the float shoe and supported by and movably coupled to the upper and lower expansion segments.

61. (New) The apparatus of claim 49, wherein each upper expansion segment comprises:

a portion defining a surface including a hinge groove for pivotally coupling the upper expansion segment; and

wherein each lower expansion cone segment comprises:

a portion defining a surface including a hinge groove for pivotally coupling the lower expansion segment to the lower tubular support member.

62. (New) The apparatus of claim 61, wherein each upper expansion segment is tapered in the longitudinal direction; and wherein each lower expansion segment is tapered in the longitudinal direction.

63. (New) A collapsible expansion device comprising:

an upper tubular support member comprising an internal flange;

an upper cam assembly coupled to the upper tubular support member comprising:

a tubular base coupled to the upper support member; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper expansion segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the internal flange of the upper tubular support member;

a lower tubular support member comprising an internal flange;

one or more frangible couplings for releasably coupling the upper and lower tubular support members;

a lower cam assembly coupled to the lower tubular support member comprising:

a tubular base coupled to the lower tubular support member; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper expansion segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower expansion segments interleaved with cam arms of the lower cam assembly, each lower expansion segment pivotally coupled to the internal flange of the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly;

wherein the lower expansion segments interleave and overlap the upper expansion segments; and

wherein the upper and lower expansion segments together define an external surface for plastically deforming and radially expanding the expandable tubular member.

64. (New) The assembly of claim 63, wherein each upper expansion segment comprises:

a portion defining a surface including a hinge groove for pivotally coupling the upper

expansion segment to the upper tubular support; and

wherein each lower expansion segment comprises:

a portion defining a surface including a hinge groove for pivotally coupling the lower expansion segment to the lower tubular support member.

65. (New) The assembly of claim 63, wherein each upper expansion segment is tapered in the longitudinal direction; and wherein each lower expansion cone segment is tapered in the longitudinal direction.

66. (New) An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:

a tubular support member;

a collapsible expansion device coupled to the tubular support member;

an expandable tubular member coupled to the collapsible expansion device;

means for displacing the collapsible expansion device relative to the expandable tubular member; and

means for collapsing the expansion device.

67. (New) The apparatus of claim 66, wherein the tubular support member comprises an upper tubular support member comprising an internal flange and a lower tubular support member comprising an internal flange; wherein the expansion device comprises:

an upper cam assembly coupled to the upper tubular support member comprising:

a tubular base coupled to the upper support member; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper expansion segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the internal flange of the upper tubular support member;

a lower cam assembly coupled to the lower tubular support member comprising:

a tubular base coupled to the lower tubular support member; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper

expansion segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower expansion segments interleaved with cam arms of the lower cam assembly, each lower expansion segment pivotally coupled to the internal flange of the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly; and wherein the apparatus further comprises:

means for releasably coupling the upper tubular support member to the lower tubular support member; and

means for limiting movement of the upper tubular support member relative to the lower tubular support member.

68. (New) The apparatus of claim 67, further comprising:

means for pivoting the upper expansion segments; and

means for pivoting the lower expansion segments.

69. (New) The apparatus of claim 66, further comprising:

means for pulling the collapsible expansion device through the expandable tubular member.

70. (New) A collapsible expansion device, comprising:

an upper cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper expansion segments interleaved with the cam arms of the upper cam assembly;

a lower cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper expansion segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly;

a plurality of lower expansion segments interleaved with cam arms of the lower cam assembly, each lower expansion cone segment mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly;

means for moving the upper cam assembly away from the lower expansion segments; and

means for moving the lower cam assembly away from the upper expansion segments.